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PCB Concentrations in Striped Bass and Eggs

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PCB CONCENTRATIONS IN STRIPED BASS AND EGGS

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16. ABSTRACT

The research project studied the accumulation of Polychlorinated biphenyls (PCB) in ppm of striped bass which spawned in the Chesapeake Bay.

Samples were collected in the spawning areas of the Chesapeake Bay region including Nanticoke, Choptank, Elk, Potomac, Rappahannock, and James Rivers.

Data includes the PCB Concentration in females, as well as eggs of striped bass.

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I. Introduction

Polychlorinated biphenyls (PCB's) have been increasingly recognized as a significant environmental pollutant.

In a previous survey of the Upper Chesapeake Bay conducted by Westinghouse Ocean Research Laboratory under contract to the Maryland Department of Natural Resources, the PCB's were found to average 12 ppt in the water column - nearly the same value found in Lake Michigan where the salmonoid fish species are unfit for human consumption (exceeding FDA tolerance levels of 5 ppm) (Munson, et. al., 1975).

Laboratory experiments have shown that some fish species accumulate PCB's more than 10,000 times those levels present in the water. Therefore, PCB's in the water column at even parts per trillion levels could have significant detrimental effects on the fishery resource (Kleinert, 1975).

Many experiments with finfishes have indicated that exposure to PCB's has in many cases hindered or prevented reproduction (Hansen, 1975; Nebeker, 1975). A PCB concentration as low as 1 ppm has been shown to drastically reduce the hatachability of trout eggs. PCB accumulation in the water column and consequently in fishes might therefore have an additional less immediately evident but possibly more detrimental and lasting effect on the fishery.

In 1975, an estimated total of 8,604,000 pounds of striped bass were caught in the U.S. and sold at an ex-vessel price to the fishermen of $3,993,000.00. Of those, 2,722,216 pounds were caught in Maryland, at a value of $1,064,168.00 (NMFS, 1976).

It was in light of these facts that this study was undertaken. Its aims are twofold. First, the results serve as a good approximation of PCB levels in the striped bass which spawn in the bay. This gives an indication of any immediate danger to the striped bass fishery which might exist in the form of unacceptable PCB concentrations in the fish flesh. In addition, in the analysis of striped bass roe for PCB content, this study serves as a pilot study for future ones which might possibly test the effects of PCB's on striped bass reproduction.

II. METHODS AND MATERIALS

A. Collection and Preparation of Samples for Chemical Analysis

Thirty-three female, two male and two striped bass of unknown sex were collected from the following spawning areas in the Chesapeake Bay region (Figure 1): The Nanticoke, Choptank, Bohemia, Sassafras, Elk, Little Elk, Potomac, Rappahannock, and James Rivers. Due to an unusually early spawn and a delay in the contract award, no samples were obtained from the Patuxent River. Because the James River was closed to fishing during the spawning period, no samples were collected there during that time. However, previously collected and frozen samples of female fish without roe were obtained for the study through Dr. Robert Huggett at the Virginia Institute of Marine Sciences.

Assisting in providing samples for the program were the Chesapeake Bay Institute, the Chesapeake Biological Laboratory, the Fisheries Department of the Maryland Department of Natural Resources, and the Annapolis Field Office of the Environmental Protection Agency (Region 3).

In the lab, the length to the nearest centimeter, the weight to the nearest gram, and the general condition of each fish (excluding the VIMS samples) was recorded. The sex of each individual was determined as well. Each fish was scaled and cleaned. The liver from each fish was frozen. From each female fish, one ovary was removed and frozen whole. From the remaining ovary several subsamples of roe were weighed out and frozen individually. A one to one and one half inch steak as taken from each fish just posterior to the pectoral fins and anterior to the dorsal fin, wrapped in aluminum foil and frozen immediately. The remainder of each fish was wrapped and frozen whole and is being stored at the Westinghouse Annapolis facility awaiting transfer to the Annapolis Field Office of EPA.

The frozen meat and roe subsamples were prepared for chlorinated hydrocarbon analysis at the Annapolis facility. Meat subsamples were thawed, diced and blended to a purée. Approximately twenty-five gram aliquots of meat subsamples were weighed to the nearest hundredth gram. Roe samples were thawed and 25 gram aliquots of eggs from each fish for which eggs were available were also weighed out. Each of these meat and egg samples was then individually ground in a mortar and pestle with three to five times its wet weight in anhydrous sodium sulfate. These samples were allowed to stand for about thirty minutes and then ground again to insure against caking. The powdered preparations were then double wrapped in aluminum foil, taped, labeled and kept dry at room temperature under dessicant prior to shipment for analysis. All materials, i.e., glassware, blender parts, mortars and pestles, were washed in hot soapy water, rinsed thoroughly, dried and subsequently rinsed in acetone and hexane prior to use in the preparation of each sample.

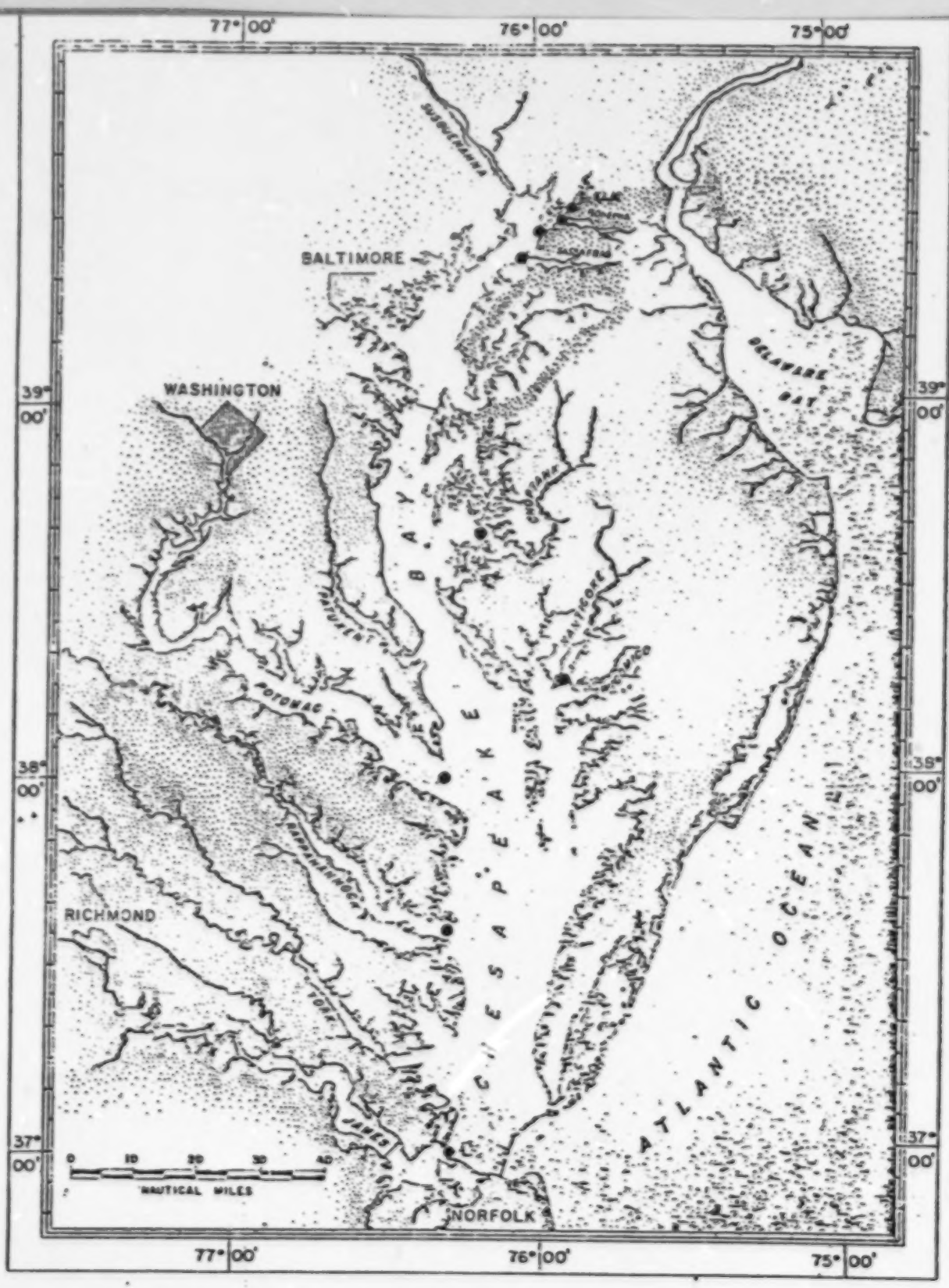

FIGURE 1. Spawning areas of the Chesapeake Bay region used as sampling locations.

B. Chemical Analysis

The gas chromatographic analysis of the samples prepared as described above were performed by the Analytical Bio Chemistry Laboratories (P. O. Box 1097, Columbia, Missouri 65201). For each sample, the sample matrix was packed in a 22 mm inside diameter (ID) column and extracted by percolating 250 milliliters of 6% diethyl ether hexane through the column. The eluate was collected, evaporated, and brought to a 25 milliliter volume. The sample weights were provided by Westinghouse and the sample concentration was generally 1 gram per milliliter. A 5 milliliter aliquot was drawn and added to a 4 inch florisil column topped with 1/2 inch of anhydrous sodium sulfate. The polychlorinated biphenyls were eluded with 150 milliliters of hexane. The eluate was concentrated to 10 milliliters and a few microliters were injected with a Ni_{63} electron capture detector. The GLC conditions were as follows:

Injector: 235°C

Column: 205°C
a 1.5% OB17
2.0% OV210
on Gas Chromatograph Q 100/120 mesh,
4 mm ID by 6' length, N_2 flow
approximately 100 ml/minute

Detector: 300°C
Ni_{63} electron capture detector with
an electrometer setting 3×10^{-10}
amp full scale.

A 2 milliliter aliquot of the diethyl ether hexane extract was drawn and evaporated and the residue weighed and reported as % fat.

All calculations were based on the extract sample weights supplied by Westinghouse. Quantitation and identification of PCB's pose several problems, especially when they exist in a weathered condition. Consequently, the last four peaks of ten peaks for Aroclor 1254 were summed and used for quantitation. This was to avoid p,p'-DDE and chlordane interferences. The last eight peaks of eleven peaks were summed and used for quantitation of Aroclor 1260. The first five peaks of eleven total peaks of Aroclor 1242 were summed and used for quantitation. These were judgements based on peak height ratios and possible interferences which might exist in the sample extract.

For the extracts which have p,p'-DDE and chlordane components in the scan, the PCB's will be separated from chlordane and p,p'-DDE components by silicic acid column separations. These additional samples cleaned up by silicic acid will verify the quantitative results for the PCB's obtained in the analyses described above and will also give semi-quantitative results for chlordane and p,p'-DDE.

III. RESULTS

The ppm concentrations of the PCBs found in the samples are given in Table I, as well as the % fat in each sample.

The average PCB concentrations in the fish meat samples and the average concentrations in the egg samples from each individual spawning area surveyed are shown on the map in Figure 2.

Figure 3 graphically describes the results of the linear regression analysis comparing ppm PCB concentrations in the flesh of each female fish to that in her eggs.

Figure 4 shows the results of the same analysis after the ppm concentrations have been corrected taking into consideration the different % fat values in each of the samples.

Copies of the Gas Chromatograph traces are included in Appendix A of this report.

TABLE I

PCB CONTENT IN FEMALE AND EGGS OF
STRIPED BASS FROM THE CHESAPEAKE BAY

Sample Number	Location	Length (cm.)	Weight (gm.)	PCB Content in ppm					
				Flesh			Eggs		
				ppm	PCB	% fat	ppm	PCB	% fat
1	Nanticoke	61.60	3,899	0.46	1260	2.8	2.56	1260	29.6
2	Nanticoke	97.16	13,381	0.48	1254	0.8	5.75	1260	19.7
3	Nanticoke	91.44	9,072	0.47	1254	0.3	11.2	1260	22.6
4	Nanticoke	68.58	4,990	0.47	1254	2.5	3.08	1260	33.3
5	Nanticoke	67.31	3,856	0.54	1260	2.3	(male)		
6	Potomac	65.53	3,289	0.47	1254	2.0	3.54	1260	31.2
7	Potomac	72.39	5,239	0.42	1254	1.8	2.63	1260	32.6
8	Potomac	66.04	5,353	0.14	1260	1.3	3.08	1260	28.9
9	Potomac	64.77	4,082	0.50	1254	1.4	6.57	1260	24.2
10	Potomac	60.96	3,969	0.24	1254	1.4	1.68	1260	14.2
11	Sassafras	60.50	3,740	0.15	1254	1.3	2.02	1260	24.5
12	Sassafras	62.30	4,086	0.11	1254	0.8	3.72	1260	26.7
13	Bohemia	63.30	3,987	0.26	1260	1.2	4.17	1260	28.2
14	Bohemia	54.7	2,723	0.27	1254	1.5	4.32	1260	29.1
15	Bohemia	57.0	2,910	0.20	1254	1.1	3.07	1260	28.5
16	Bohemia	59.3	3,680	{0.08 / 0.14}	{1242 / 1260}	0.9	3.88	1260	27.1
17	Bohemia	68.5	5,584	0.51	1254	2.5	4.44	1260	28.6
18	L. Elk	69.5	5,770	0.24	1254	1.8	3.16	1260	32.2
19	L. Elk	39.4	3,528	0.07	1254	0.7	2.46	1260	29.6
20	Elk	61.4	3,935	<0.06	1254	1.0	1.32	1260	31.3
21	Elk	58.0	3,219	0.12	1254	0.9	4.36	1260	35.4
22	Elk	51.0	3,224	0.05	1254	1.0	1.77	1260	30.8
23	Choptank	80.01	7,938	0.24	1260	0.7	7.12	1260	28.7
24	Choptank	76.84	7,371	0.21	1260	0.6	6.47	1260	29.4
25	Choptank	80.01	7,031	0.11	1254	0.5	4.00	1260	30.3
26	Choptank	59.06	3,629	0.14	1254	0.9	2.74	1260	14.1
27	Choptank	60.96	3,515	0.08	1260	0.5	3.04	1260	21.9
*28	James	93.0	10,860	1.27	1260	4.3			
*29	James	59.0	3,040	0.62	1260	3.2			
*30	James	74.0	6,460	0.67	1260	5.9			
*31	James	69.0	5,660	1.32	1260	7.1			
*32	James	74.0	5,430	1.65	1260	7.7			
*33	Rappahannock	76.0	6,865	{10.9 / 10.9}	{1242 / 1254}	10.3			
*34	Rappahannock	67.0	5,085	1.14	1260	7.8			
*35	Rappahannock	63.0	4,095	1.49	1260	10.5			
*36	Rappahannock	69.0	6,545	0.62	1260	10.9			
*37	Rappahannock	81.0	7,980	1.66	1260	9.7			

* Female meat only from VIMS

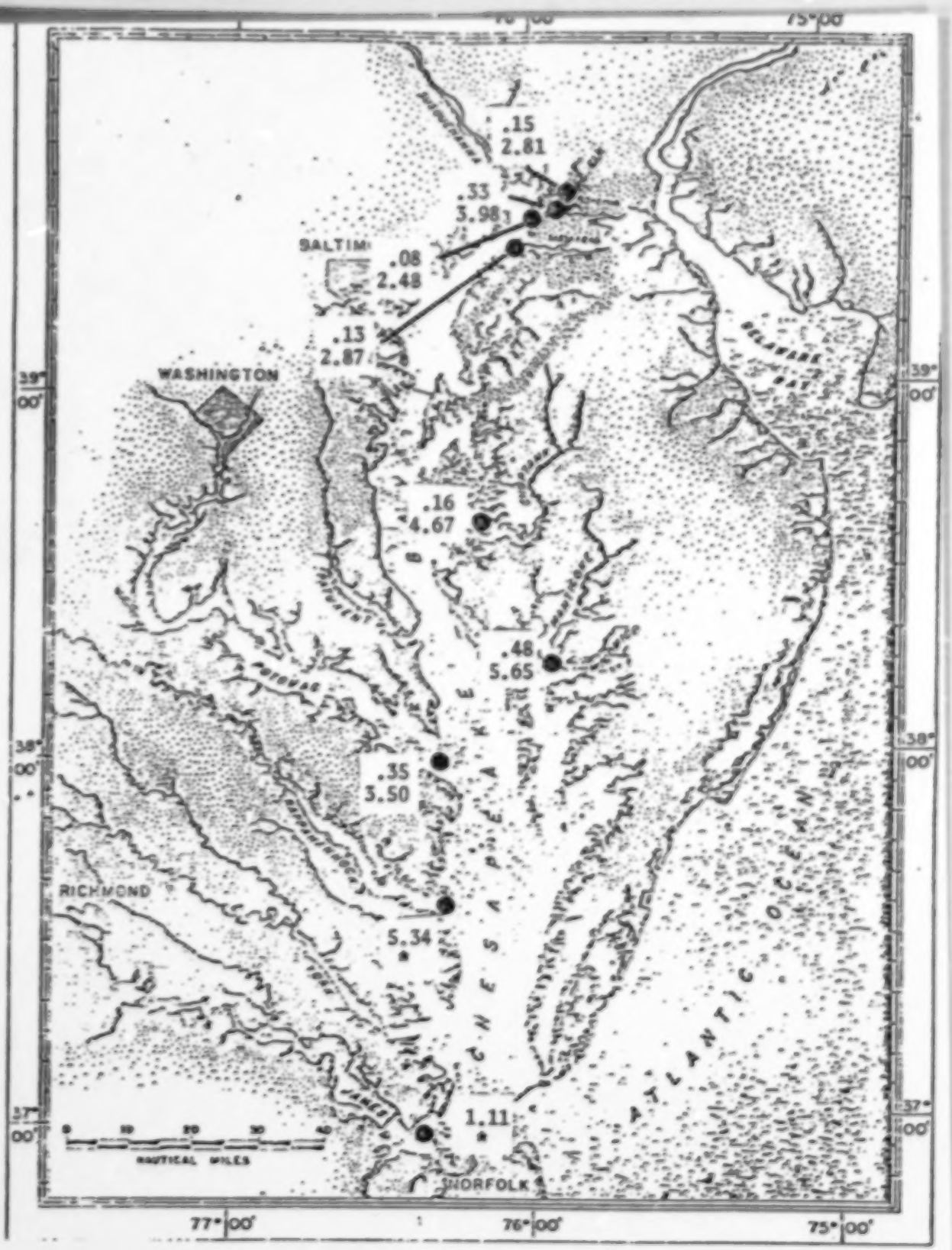

FIGURE 2. Average concentrations (ppm) of PCBs in Striped Bass flesh and eggs from each of the sampling areas. (* no eggs available for study)

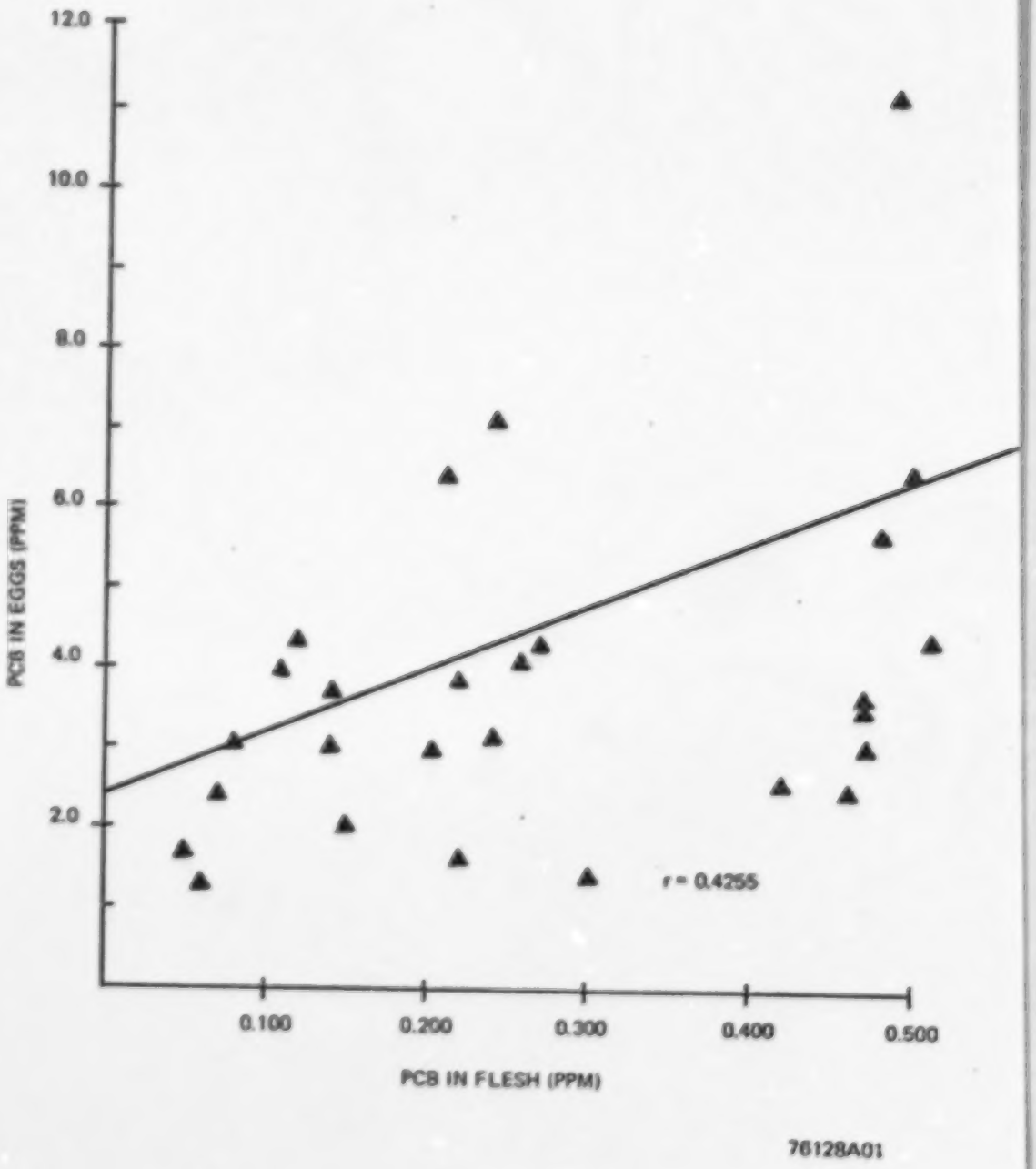

Figure 3. Relationship of PCB Concentration in Female Striped Bass Flesh and Their Eggs.

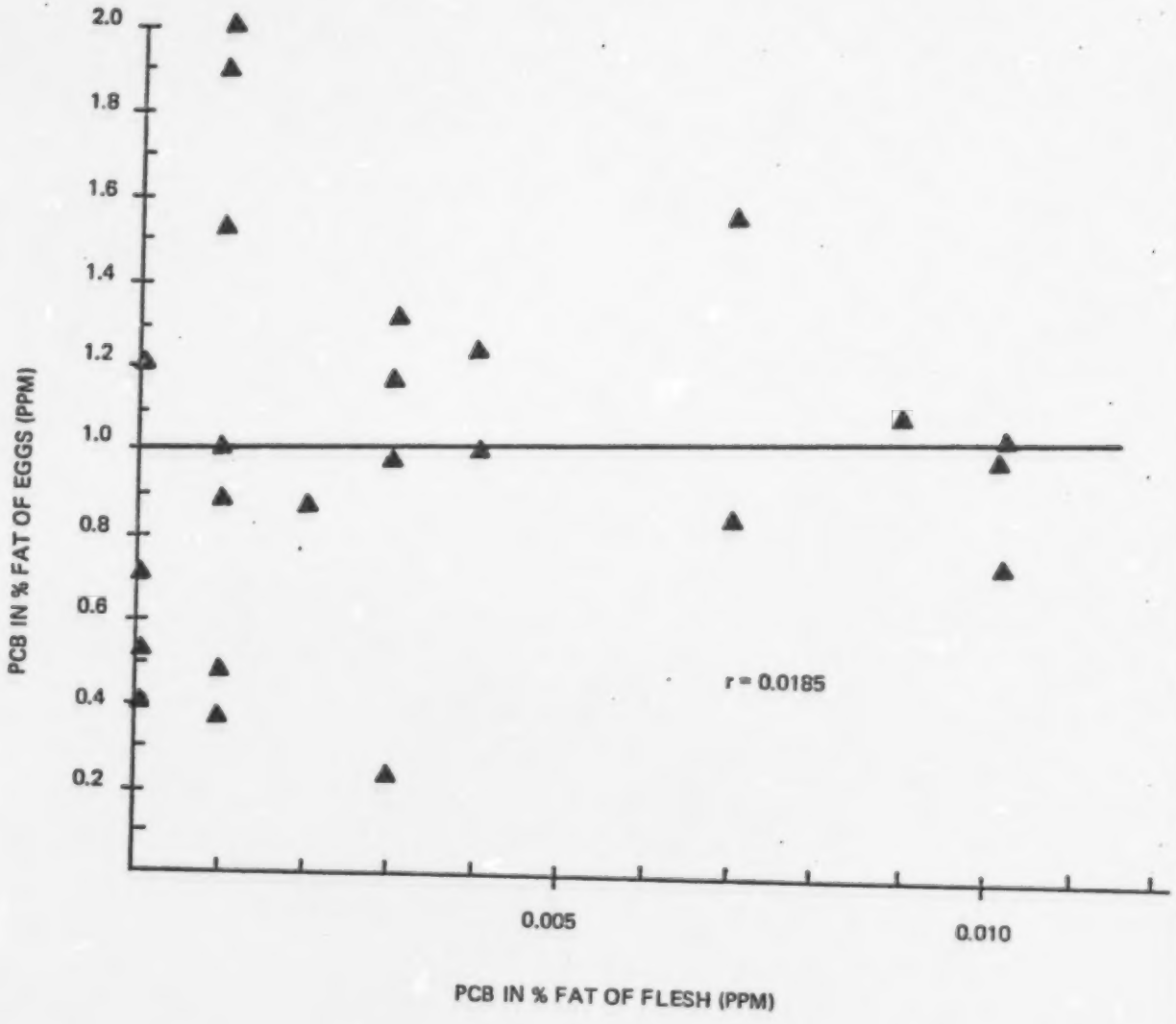

Figure 4. Relationship of PCB Concentration in Fat Content of Female Striped Bass Flesh and Their Eggs.

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